Chaos Control in Attitude Dynamics of Automotive Disc Brake Squeal

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ABSTRACT
Disc brake squeal is a nonlinear transient phenomenon of the friction-induced self-excited instability of an automotive brake system. In most situations, decreasing this squeal noise to some extent during braking is very important for the comfort of passengers, which is dependent on an absence of chaos; consequently, suppressing chaos becomes quite important. Therefore, this study aims to confirm chaotic motion and apply synchronization to a chaotic disc brake system to control chaos. Rich dynamics of the disc brake system were studied using a bifurcation diagram, phase portraits, a Poincare' map, frequency spectra, and Lyapunov exponents. First, the largest Lyapunov exponent was estimated using synchronization to identify periodic and chaotic motions. Next, complex nonlinear behaviors were thoroughly observed for a range of parameter values in the bifurcation diagram. Finally, a continuous feedback control method based on synchronization characteristics was proposed to eliminate chaotic oscillations, improve the performance of the automotive disc brake system, and prevent brake squeal noise from occurring. Numerical simulations were utilized to verify the feasibility and efficiency of the proposed control technique.

Keywords: Disc brake; Bifurcation; Chaos; Lyapunov exponent; Synchronization

REFERENCES